Office of Building Technology, State and Community Programs

The EE Office of Building Technology, State and Community Programs (OBT), supports the energy needs of the buildings sector of the economy. Its goals are to develop cost-effective, renewable, demand-side technologies that have the potential to provide 25% of the energy requirements of new buildings in the near term and 50% in the long term.

DOE/EE OFFICE OF BUILDING TECHNOLOGY, STATE AND COMMUNITY PROGRAMS

NREL Funding by Fiscal Year

($ in millions--Budget Authority)

	Fiscal Year*				
Office of Building Technology, State and Community Programs	1995	1996	1997	1998	1999
Operating					
Solar Building & Technology Research (EB21)	$2.9	$0.7	$0.7	$0.8	$0.8
Building Systems (EC10)	5.3	4.9	4.9	5.1	5.2
Building Envelopes (EC12)	0.3	0.6	0.6	0.7	0.7
Building Equipment (EC13)	0.7	0.2	0.2	0.2	0.2
Codes and Standards (EC14)	1.5	1.0	1.0	1.0	1.0
Evaluation and Planning (EC2801)	0.0	0.1	0.1	0.1	0.1
Subtotal Operating	$10.8	$7.5	$7.5	$7.8	$8.0
Capital Equipment (35EC)	0.1	0.2	0.2	0.2	0.2
Total Building Technology, State/Community Programs	$10.9	$7.7	$7.7	$8.0	$8.2
Percent of Total Laboratory Funding	4%	4%	4%	4%	4%

*FY 1995 and FY 1996 are actuals; FY 1998 and beyond are projections in current-year dollars assuming 3% inflation.

NREL's work in support of the office includes developing cost-effective technologies to reduce building energy loads; improving indoor environmental quality; and providing information and materials to allow the public, lenders, and building designers to make informed decisions about energy efficiency in buildings.

Building Energy Technology

Buildings currently use 36% of U.S. energy at an annual cost of roughly $200 billion. Since the mid-1970s, through the use of increased insulation, increased equipment efficiency, and reduced

infiltration, the energy use per residential building has dropped approximately 14% while the energy intensity use in commercial buildings has remained flat. There is significant potential for additional reductions in energy use through improved system design and operation. Designs that integrate renewables with energy efficiency can produce savings of 30%-80%, with little increase in first cost.

Improving the energy efficiency and increasing the direct use of renewables in buildings would reduce conventional energy use, displace peak generating capacity and enhance our standard of living by lowering fuel bills, reducing greenhouse emissions, and improving building environments for living and working, thereby enhancing productivity and improving comfort.

NREL develops new, cost-effective, and environmentally beneficial technologies and encourages the full use of currently available technologies within advanced building equipment and envelope systems. NREL's building energy technology program integrates building envelope, equipment, and systems with renewable strategies in the context of whole-building design.

Not only is the research *in* the building—the research *is* the building!

With more than 60% of the electricity consumed in the United States used to heat, cool, and operate buildings, the potential savings is enormous. Many of today's most advanced energy-saving technologies are being developed, tested, and optimized at NREL's new Thermal Test Facility (TTF).

In addition to providing state-of-the-art laboratory space for research activities, the TTF building itself serves as a large-scale research project. The building showcases integrated energy-efficiency features that should reduce energy use by 70%; NREL researchers are monitoring how well the integrated system performs.

In the TTF, research focuses on building design strategies that improve energy performance by incorporating features such as daylighting, passive solar heating, shading and natural cooling. An energy management system controls ceiling fans to distribute solar heat, while motion and photosensors keep electric lighting costs to a minimum.

The building houses several sophisticated laboratories, including labs to study heat transfer during solar heating, ventilation testing, and thermal imaging of air temperatures throughout a room.

During the planning period NREL will focus on whole-building energy options that integrate renewables with energy efficiency, allowing cost trade-offs among building system components that optimize overall system performance without increasing building cost, while minimizing non-renewable energy use. To help fulfill this strategy, NREL completed construction of the Thermal Test Facility in FY 1996 (see sidebar, previous page). This facility allows NREL to centralize existing laboratories and provide a location for a building industry user facility for advanced energy systems research.

NREL will use cost-sharing agreements with industry consortia and in-house research to accelerate development and adoption of integrated building systems and construction processes that improve energy efficiency. Many building energy systems research activities planned during the next 5 years incorporate industry involvement and collaboration. At the direction of DOE, NREL is supporting the Building America Program, an industry initiative with a consortia of major building developers and suppliers. The Building America Program accelerates development of residential building technologies using a systems approach that integrates engineered components and systems with volume production techniques. Future plans call for establishing an expanded consortia program and a program to provide technical support to industry-defined research needs that result from the consortia program. The Laboratory also plans the following industrial collaborations:

During the planning period NREL will focus on whole-building energy options that integrate renewables with energy efficiency...

- Passive Solar—Joint development and evaluation of advanced design tools with the Passive Solar Industries Association, the American Institute of Architects, and the building industry

The Building America Program accelerates development of residential building technologies using a systems approach...

- Electrochromic Materials—Cost-shared development of large-scale electrochromic devices with Lawrence Berkeley Laboratory and the window industry, focusing on durability issues

- Dessicant Systems—Cost-shared development of advanced desiccant systems with Oak Ridge National Laboratory that improve air quality and humidity control in small commercial building space-conditioning systems

- Short-Term Energy Monitoring—Whole-building testing program aimed at industry's need for rapid evaluation of new system designs based on several days of performance data

- Exemplary Buildings Program—National Park Service and building industry partnerships showcasing use of renewable technologies to reduce energy use by 40%–90% in residential and commercial buildings. Prominent examples are the NREL's Solar Energy Research Facility, Visitor's Center, and Thermal Test Facility, as well as residences that do not require heating or cooling systems.

- Energy-10—Industry partnership to develop quick energy design evaluation tool for commercial buildings that allows design optimization throughout the design process.

- Home Energy Rating System (HERS)—Develop software evaluation procedures for HERS to establish standard methods to include home energy performance within energy-efficiency mortgages. The evaluation method, "Building Energy Stimulation Test" is being adopted by the International Energy Agency; the American Society of Heating, Refrigerating, and Air-Conditioning Engineers; several state energy offices; and other countries as the basis for software certification associated with HERS and energy code compliance

NREL architects and engineers worked with industry to develop Energy-10, a quick and easy computer program that helps optimize energy saving features of buildings at the design stage; Energy-10 won a prestigious award from *Architecture* magazine in 1997.

Electrochromic Windows

Research is in progress within the NREL building energy technology program and at a number of industries and research institutions worldwide to develop electrochromic coatings to control the light and solar heat transmitted through building windows. Applying these coatings to windows creates "smart windows" that use the electrochromic phenomenon that changes the light transmission and reflection properties of certain thin-film materials in a controlled and reversible manner by applying a small direct-current voltage.

A modest program on electrochromics has been under study by DOE since 1978 to develop practical coatings for industry adoption. Recently NREL and Lawrence Berkeley Laboratory jointly developed a New Initiative Program for DOE whose objective is to accelerate electrochromic window technology development and transfer to private industry.

"Smart windows" have the following benefits:

- Maximize daylighting savings (lighting is now 30%-60% of commercial building energy use) while reducing glare and improving visual comfort and occupant performance
- Reduce cooling energy consumption and improve thermal comfort by blocking unwanted solar heat gain
- Reduce peak cooling loads and decrease the required size of the heating, ventilating, and air conditioning system
- Provide a load shaping and peak electric demand limiting capability

This technology can directly address the performance of window and lighting systems that currently account for more than $50 billion/year in annual energy expenditures and additional billions for investment in new generating capacity.

In addition to energy savings, electrochromic windows should result in smaller heating, ventilation, and air-conditioning systems (with reduced chlorofluorocarbon requirements), lower peak electric demand, and better load shapes. Growth in U.S. electric demand could be reduced by 1000-2000 MW/year with widespread use of these coatings. First-cost savings from these systems may offset a large fraction of the window cost. Peak load reductions will result in additional operating cost savings.

NREL accelerates the market introduction of "smart windows" for building applications by developing a balanced R&D program that includes basic mechanism research, process research, device development and modeling, and develop-ment of standardized tests of performance, reliability, and durability.

"Smart windows" use electrochromic coatings to control light and heat transmission; NREL's patented process for producing these films is up to 100 times faster than conventional deposition techniques.

NREL will collaborate with Lawrence Berkeley Laboratory, private industry, universities, and other DOE contractors to improve the underlying technological basis for a practical, cost-effective, and durable electrochromic window coatings for architectural applications. Development of a better understanding of the basic mechanisms critical to the large-scale production, operation, and longevity of electrochromic windows will be emphasized.

Improved coating designs and production processes will be sought within the scope of NREL's collaborative activities. Both short-term and long-term durability testing will be conducted to validate the understanding and predictive capabilities of proposed degradation mechanisms. Application analyses will be conducted to determine the practical effects of different performance characteristics obtainable from different electrochromic window design options.

Industry will provide developmental and prototypical electrochromic devices for study at NREL. These devices will be analyzed to determine their electrochromic performance and their probable degradation mechanisms; they will be tested to determine their actual short-term (accelerated) and long-term performance characteristics. NREL will help industry develop testing procedures and standards to assure that electrochromic windows meet market expectations. NREL staff will continue to participate in industry consensus organizations such as the American Society for Testing and Materials and the National Fenestration Rating Council as the principal forums for developing procedures and standards.